Imaging at the Nanoscale
ELEC 571

Overview

This is a part seminar and part lecture course that surveys the techniques used in imaging submicron and nanometer structures with an emphasis on applications in engineering, chemistry, physics, biology, and materials science. The course includes an introduction to scanning probe microscopy, scanning and transmission electron microscopy, and near field and super resolution optical microscopy. Included in this course will also be discussions on the fundamental and practical aspects of digital image acquisition, processing, analysis, and artifacts.

Course Outcomes

At the conclusion of ELEC 571, you should have

- Acquired and demonstrate advanced knowledge in the foundational applications in nanoscale imaging including familiarity with past and current scientific literature.
- Developed the ability to utilize nanoimaging instrumentation and image processing software to identify, formulate, and overcome scientific and engineering problems such as these techniques apply to your research.

Instructor

Kevin Kelly
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Prerequisites Sophomore-level understanding of physics, chemistry, mathematics

Times and Places

Office Hours: M 10-12 BRK 326, TThu 1-2:30pm Brockstein Pavilion, or appointment
Lectures: RAYZOR 106, MW 3:00-4:30pm *Owlspace:* Elec 571 001 F14

CHECK IT OUT—A POCKET MICROSCOPE!
OOH! LET'S LOOK AT STUFF!
THE TIP OF THIS PENCIL IS NEAT.
THIS QUARTER IS REALLY SCRATCHED.
LET'S LOOK AT THE SKIN UNDER OUR FINGERNAILS!
MINUTES LATER...
OH GOD OH GOD

Required Reading *Will be posted on the Owlspace website*

Grading

33% - Homework, Paper summaries, Quizzes
33% - Presentation
33% - Final paper
ALL assignments must be completed, or you will receive an incomplete.

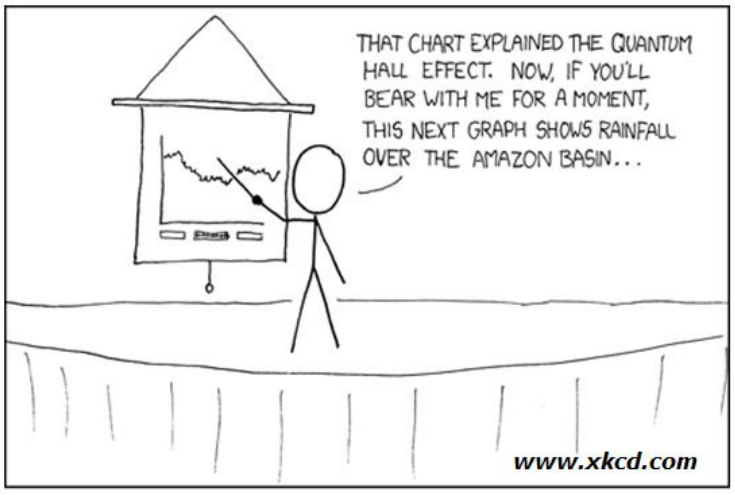
Project

For the second half of the semester, each person will present a 20 minute talk and write an accompanying 7 to 10 page paper expanding on the topic in relation to the concepts discussed in the class.

Students with disabilities

Any student with a documented disability needing academic adjustments or anyone needing other accommodations is requested to speak with me during the first two weeks of class. All discussions will remain confidential. Students with disabilities should also contact Disabled Student Services in Ley Student Center.

{The information contained in the course syllabus may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.}


THAT CHART EXPLAINED THE QUANTUM HALL EFFECT. NOW, IF YOU'LL BEAR WITH ME FOR A MOMENT, THIS NEXT GRAPH SHOWS RAINFALL OVER THE AMAZON BASIN...
www.xkcd.com

IF YOU KEEP SAYING "BEAR WITH ME FOR A MOMENT", PEOPLE TAKE A WHILE TO FIGURE OUT THAT YOU'RE JUST SHOWING THEM RANDOM SLIDES.

Course Topics

Digital Image Processing

- A. Formation and acquisition
- B. File formats and compression
- C. Fourier Space
- D. Filtering
- E. Registration and feature tracking
- F. Software (Photoshop,Matlab,UTHSCA ImageTool,NIHImage,GIMP, Gwyddion,WSXM)

Photon Image Sensors

- A. Photodiodes
- B. CCD/CMOS arrays
- C. Photomultiplier tubes/Scintillation detectors
- D. Spectrometers
- E. Detector noise and sensitivity

Optical Microscopy

- A. Electromagnetic wave equation & the diffraction limit
- C. Far-field vs. near-field
- D. Confocal and super resolution microscopy
- E. Spectroscopy
- F. Negative index materials and superlensing

Electron Microscopy

- A. Electron optics
- B. Scanning vs. transmission
- C. Diffraction
- D. Electron holography
- E. Spectroscopy

Scanning Probe Microscopy

- A. Basic operation
- B. Electron tunneling
- C. Force microscopy
- D. Photon tunneling
- E. Probe spectroscopy